PART IV.

DETAILED REPORTS ON THE VARIOUS BAMBOO AREAS IN BURMA AND INDIA.

POSSIBLE SITES FOR BAMBOO PAPER-PULP MILLS IN BURMA.

BURMA AREA NO. I. (*See portion marked* **A** *on map.*)

The Thonzé Reserve of the Tharrawaddy Division.

(1) *Name and Situation.*

The forests with which this scheme is concerned are situated in the catchment area of the River Thonzé, which drains a portion of the western slopes of the Pegu Yoma in the Tharrawaddy Division. This river finds its source in the main ridge of the Yomas and follows a winding course south-westwards, through the lower hills of the range until it emerges into the plains at Wéywa. Thence it passes between deep banks to the village of Thonzé, where it cuts the railway, and eventually six miles lower down flows into the Myitmaka at Sanywé. (See map.)

This area, which has been chosen as a possible locality from which bamboos might be exploited to supply a pulp-mill, lies to the north of the Okkan Reserve of the Rangoon Division, which is dealt with hereafter, and is a continuation of those forests, though lying in a different catchment area. Again, to the north of this area, lies the Kadin Bilin reserve, drained by the Bilin River, and also a continuation of the same block of forest, which stretches northwards from the Okkan river along the western slopes of the Pegu Yoma for a distance of many hundreds of miles.

(2) *Description of the forests.*

The area is, for the most part, covered with dry deciduous teak, pyinkado and bamboo forests, with patches of evergreen in the moister localities, a large number of teak plantations near the western boundary and 8,000 acres of inferior forests, ceded to the Karens, in which to practise shifting cultivation. By far the greater portion of the area is fully stocked with bamboos of four or five different species, and only in

some of the plantations, evergreen and Karan areas, are they in any way scarce. These forests and those of the Okkan which are described hereafter, resemble each other, especially as regards the growth of bamboos.

(3) *Area of the forest covered with bamboos.*

The total area of the forests situated in the catchment area of the Thonzé River is 69,734 acres, which is made up as follows:—

1. Area from which bamboos can be exploited	40,037 acres.
2. Evergreen forest	8,000 ,,
3. Karen area in which shifting cultivation is practised . . .	8,200 ,,
4. Area containing bamboos but from which exploitation is difficult	13,497 ,,
TOTAL .	69,734 acres.

The area, therefore, with which we are concerned is 40,037 acres, from which bamboos can be exploited without difficulty. It may here be mentioned that, out of the 13,497 acres in which bamboos occur, but from which exploitation is difficult, 4,565 acres are situated above the waterfall on the Kodugwé tributary and 8,932 acres are situated on the steep slopes of the main ridge of the Yomas, whence extraction would be difficult and costly.

(4) *Species of bamboos and mode of growth.*

The prevailing species in these forests are *Cephalostachyum pergracile* (Tinwa) and *Bambusa polymorpha* (Kyathaung); *Dendrocalamus strictus* (Myin) is common on the ridges and *Teinostachyum Helferi* (Wathabut) along the streams and in the evergreens. From Appendix I it will be seen that the average length of 200 cut stems of Tinwa is 28 feet and mid-girth 5·7″, while an equal number of Kyathaung average 33 feet and 8·8″ mid-girth. An important point in the growth of bamboos is the number of new stems put out yearly as compared with the number of old stems in the clump. From Appendix I we find that the average number of Tinwa stems per clump is about 9 of which 23 per cent. are new and 77 per cent. old, or in round figures as 1 is to 3. In the case of Kyathaung the number of new stems is proportionally greater. The figures show roughly 11 stems per clump, of which 30 per cent. are new and 70 per cent. old, or as 1 is to $2\frac{1}{3}$.

(5) *Possible factory sites.*

There are two possible factory sites. One is where the Thonzé river cuts the railway at the village of Thonzé, two miles south of Tharrawaddy railway station (see map), the other is near Insein on the Hlaing or Myitmaka river. Were the latter site to be chosen, the Thonzé and Okkan bamboo areas could be worked together. The advantages of the latter site will be fully described under this head in the Okkan scheme. (See page 48, section 5.)

The first suggestion is to have a mill at or near the village of Thonzé, on the banks of the river. Such a place has distinct advantages. It is on the railway and also near a good perennial stream of water. It is 12 miles by river from the edge of the bamboo area at Wéywa and 20 miles from the centre of the forests. From Thonzé, to the junction of the river with the Myitmaka at Sangwé, is 6 miles and along this stretch of river small boats loaded with 2,500 to, 3,000 lbs. of rice ply without difficulty. From the junction of the rivers at Sangwé boats carrying 10—12,000 lbs. of rice go down to Rangoon. It might be thought advisable to place the factory at Sangwé, but this is not practicable, as the river overflows its banks in the monsoon, a circumstance which would practically stop all work during those months and possibly damage the mill.

(6) *Outturn.*

As will be done when calculating the outturn from the Okkan and Hlaing Yoma Reserves, the figures of yield for this reserve are based on the average outturn per acre of all the sample plots situated in the two bamboo areas, namely, those of the Thonzé and Okkan Reserves. This has been done in order to obtain a more reliable figure, as the forests of both divisions are of the same type as far as bamboos are concerned.

The area of the bamboo-yielding forests in the Thonzé Reserve has been shown as 40,037 acres. From Appendix I it will be seen that an acre yields 8,254 lbs. of dry internodes of *Cephalostachyum pergracile* (Tinwa) and 9,255 lbs. of dry internodes of *Bambusa polymorpha* (Kyathaung). Thus the gross yield of pulpable material works out at 312,288 tons, or, working on a 5-year rotation, the sustained yield of dry internodes comes to 62,417 tons per annum.

Were the Kadin Bilin catchment area, which lies directly north of the Thonzé Reserve and which is a continuation of the same block of forests, to be worked in addition, the outturn could be nearly doubled.

The export of bamboos from the Thonzé Reserve is already considerable. The bamboos are floated down the river, some are sold locally in Tharrawaddy, but the greater number are taken on down the Myitmaka to Rangoon. The outturn of all species of bamboos during the last five years was as follows:—

Year.	Number.
1905-06	629,100
1906-07	546,550
1907-08	497,000
1908-09	494,700
1909-10	503,500
Average	534,170

(7) *Lines of export.*

The bamboos are at present dragged to the main or by-streams, a distance of under a mile. They are then rafted down the main stream from 15th May to the end of November. After November and up to February, rafts can still be taken down, but they require to be pushed in places, thus rendering the cost of extraction higher. Floating is carried on down the by-streams from the commencement of the monsoon until October. The greatest distance over which floating is necessary, namely, from the foot of the main ridge of the Pegu Yoma at Kaingdagyi to Thonzé, is 32 miles. A waterfall exists on the Kodugwé, on one of the largest northern tributaries, at a distance of 7 miles from its junction with the main stream. Floating is, therefore, not possible above this point, and in estimating the area of bamboo forest, the compartments above the waterfall have been excluded from the calculation.

Once the bamboos are in the main stream no difficulties occur in floating them down to the village of Thonzé or on to Rangoon.

The question was once raised by a District Forest Officer whether by floating large quantities of bamboos down this river the floating of the teak logs, annually exported from these forests, would not be interrupted. Careful enquiry was made on this point and the present District Forest Officer and also some of his subordinates, who have been working for many years in this locality, apprehend no difficulties.

The present method by which bamboos are extracted, is to make rafts of three sections, each containing 300 Kyathaung or 600 Tinwa bamboos; these are floated down the upper reaches in charge of one man. As the stream widens out, the rafts are increased in size and on reaching the Myitmaka or Hlaing river, several sections are tied side by side and rafted down in lots of 6,000 to 7,000 to Rangoon.

(8) *Cost of cutting and extraction.*

The present rates for selected straight Tinwa bamboos, 20 feet in length, at Thonzé on the railway line, is Rs. 3 to Rs. 5 per 100 stems and for Kyathaung Rs. 6 per 100 and for fine selected stems Rs. 8 per 100. This includes royalty and contractor's profit. The figure of cost of extraction of bamboos on a large scale of both species, taking crooked and straight stems together, is put at Rs. 3 per 100 by the Divisional Forest Officer. This includes profits to the contractor but not royalty charges. Were the Rangoon supply to clash with that of a pulp-mill, it is possible that the price might go up 25 per cent. A safe figure on which to base the cost of extraction will, therefore, be Rs. 2-8 per 100 stems of Tinwa, and Rs. 4 per 100 stems of Kyathaung.

(9) *Cost of landing dry internodes per ton at the factory site.*

Supposing Thonzé to be selected as a mill site, the cost of landing dry internodes at the factory will be as follows :—

(*i*) *Cephalostachyum pergracile* (Tinwa).—The weight of dry internodes yielded by one Tinwa is 7·6 lbs. (See Appendix I), and it requires 295 stems to yield one ton of dry internodes. Therefore the cost of extracting 295 stems or, in other words, of landing one ton of dry internodes at Thonzé at Rs. 2-8 per 100 comes to Rs. 7-6-0 per ton.

(*ii*) *Bambusa polymorpha* (Kyathaung).—The weight of dry internodes yielded by one Kyathaung is 15·4 lbs. (see Appendix I), and it requires 145 stems to yield one ton of dry internodes. Therefore the cost of extracting 145 stems or, in other words, of landing one ton of dry internodes at Thonzé, at Rs. 4 per 100, comes to Rs. 5-12-9 per ton.

(10) *Labour.*

A certain amount of local labour is available. It is said that 12 villages situated on the Thonzé and lying between the forest and the Railway could supply 300 to 400 coolies from June to November, but that in December the number would be reduced, owing to the commencement of rice harvest. On the other hand, were a mill to be started in these parts, it is probable that a far larger number of coolies would be forthcoming, once it became known that regular labour was obtainable on piece-work.

Turning now to the amount of work a man can do, it is known from experience that a good labourer can extract about 5,000 Kyathaung stems between June and November, so that 400 men could work out 2,000,000 stems in that time. Taking one stem as yielding roughly 15 lbs. of dry Kyathaung internodes, 400 men would extract 30 million lbs. or about 13,400 tons in the six months. The above figures make no allowance for loss in transit, so that 12,000 tons would be a safer figure to quote, and this amount would not be sufficient to supply a large mill. Under the circumstances it would be necessary to import labour, either from the neighbouring districts or from India, as is done to harvest the rice crop.

There would be no difficulty in procuring contractors who would undertake to exploit the bamboos.

The official rate for labour is 8 annas a day, though probably 9 annas would have to be given. It is said that a good workman can earn Re. 1 per day during the harvest season.

(11) *Firewood.*

About 100,000 c.ft. stacked firewood is annually available from the Plains Forests. Supposing the fuel supply required for a mill to be greater than the above amount, a rough working-plan could be prepared for the Thèwa and Kauni Fuel Reserves, and the coupes so arranged that a sustained annual yield could be procured. To do this arrangement would have to be made in advance.

The price of fuel at Tharrawaddy is Rs. 2-6-0 per 100 c. ft. stacked and at Thonzé Rs. 2-12-10.

(12) *Chemicals.*

No lime is available in the vicinity of Thonzé, so that it would have to be procured from Rangoon, where the price is about 5 annas per cubic foot. Excellent lime is also available in large quantities from Moulmein. All the other chemicals necessary would have to be imported to Rangoon by sea, and taken up the Rangoon river to the factory site.

(13) *Miscellaneous facts.*

The proposed factory site is situated in the plains and is surrounded by cultivation, chiefly rice. It is not an unhealthy spot, is well situated on a fair river and close to the railway. It is just possible that a more satisfactory site could be found lower down the river, nearer Rangoon and somewhere above tidal level. The forests are not unhealthy, except after the monsoon, when fever is prevalent.

BURMA AREA NO. II. (*See portions marked* ***B*** *on map.*)

The Hlaing Yoma and Okkan Reserves of the Rangoon Division.

(1) *Name and Situation.*

These forests lie in the Rangoon Division and are known as the Okkan and Hlaing Yoma Reserves. They are situated on the western slopes of the southern extremity of the Pegu Yoma and therefore lie to the east of the Irrawaddy river. In this locality the Pegu Yoma forms a range of broken hills rising to 800 feet with considerably higher points along the main ridge. They are drained by numerous small streams which find their way into the larger feeders of the Hlaing, the most important of which is the Okkan river, which flows through the central and northern portion of the area. (See map.)

(2) *Description of the forests.*

To the east of Palôn Railway Station occur what are known as the Plains Forests, in which extensive teak plantations exist, and in which comparatively few bamboos occur. About 8 miles east of the railway commences the broken hilly ground of the Yomas covered with

moist-deciduous forests, containing teak and other species, with continuous bamboo forests up to the top of the western watershed, which constitutes the boundary of the Pegu Division. This type of heavy teak and bamboo forest with small modifications, occurs all over the hill ranges, passing northwards through the Okkan Reserves into the Tharrawaddy Division.

(3) *Area of forests covered with bamboos.*

The above-mentioned Plains Forests, which constitute the North and South Hlaing Reserves, have been eliminated from this scheme, as they contain relatively few bamboos. The areas taken into consideration are those which comprise the forests situated on the hilly ground in front of the main ridge of the Yomas and which go to make up the western watershed of the main range. For the sake of convenience, the area has been divided into two parts, according to the lines of export available, though both reserves form one continuous block of forest :—

Name of reserve.	Compartment Nos.	Area in acres.
Hlaing Yoma Reserve	9 and 13 to 28	26,701
Okkan Yoma Reserve	29 to 100	81,663
	TOTAL .	108,364

(4) *Species of bamboo and mode of growth.*

The prevailing species are *Cephalostachyum pergracile* (Tinwa) and *Bambusa polymorpha* (Kyathaung) which together make up about 80 per cent. of the bamboo growth. *Dendrocalamus strictus* (Myin) occurs on the ridges, and is often found growing on poor soil, but, for reasons stated elsewhere, this species has not been included in the scheme. Besides the above bamboos, a creeping species occurs, known as *Teinostachyum Helferi* (Wathabut) and a bamboo named *Dendrocalamus longispathus* (Waya).

The two first-named species, Tinwa and Kyathaung, are very abundant. The former is a comparatively small unarmed bamboo, with an average stem of 6″ to 7″ mid-girth and cutting into lengths of 25 to 30 feet. It yields a fairly strong stem, but not thick-walled, and is easily cut and extracted. The latter is a larger unarmed bamboo, with

a mid-girth of 8″ to 9″ and cutting into lengths of 30 to 40 feet. It is thin-walled, with small nodes from 18″ to 29″ apart and is by no means difficult to extract. Both the above-mentioned species are softer and lighter bamboos than the prevailing species of the West Coast (*Bambusa arundinacea*) and being unarmed are therefore more easy to fell and extract. (For average size and weight of these species see Appendix I.)

(5) *Possible factory site.*

There are two possible ways of dealing with this scheme. The first is to locate the pulp-mill on the Okkan river, near to the point where the river cuts the Rangoon-Prome Railway, that is, 2 or 3 miles north of Okkan Railway Station and 13 miles from the outer boundary of the Okkan Reserve. The alternative proposal is to have a mill below the junction of the Okkan and Hlaing, otherwise known as the Myitmaka river, or in the event of no suitable site being found there owing to danger from floods, further down the stream at or near Insein, which is 10 miles above Rangoon. If the first site were adopted the supply of raw material would be confined to the Okkan and Hlaing Yoma Reserves, which are themselves capable of supplying sufficient bamboos to work a large paper-pulp mill. On the other hand, were the mill placed at Insein on the Hlaing river, of which the Thonzé as well as the Okkan are tributaries, the former draining a bamboo area to the north of the latter river, and fully described above, it would be supplied from two separate bamboo areas, and at the same time would be sufficiently far down the river to allow of large boats coming up from Rangoon. The respective merits of these two sites can only be compared after the capacity of the mill has been definitely determined. In fixing the site it would be of the first importance to consider the advantage of having two areas from which supplies of raw material would be available; the question of having a greater area over which to recruit labour; and the proximity and connection by water with Rangoon, as against concentration of labour and the proportionate reduction in establishment were the bamboos procured from one reserve only. As regards the water supply, there is always a sufficient quantity flowing down the Okkan and Hlaing rivers to meet the requirements of a factory at either place. These remarks apply with equal force to the scheme for the Thonzé Reserve described above.

(6) *Outturn.*

A considerable number of bamboos are extracted annually from the Okkan Reserve, the figures for the last five years being as follows:—

Year.	No. of bamboos.
1905-06	548,600
1906-07	487,100
1907-08	660,000
1908-09	700,000
1909-10	610,000
AVERAGE	601,140

So as to obtain a more reliable figure of outturn, based on the enumerations and weighings carried out in the various bamboo sample plots, it has been decided to take the figures obtained not only from countings in the Hlaing Yoma and Okkan Reserves of the Rangoon Division, but also those obtained from the sample plots in the Thonzé Reserve of the Tharrawaddy Division. Though these three reserves lie in two different Divisions for administrative purposes, they form one continuous belt of forests in the Pegu Yoma, in which the species and mode of growth of the bamboos is for all purposes the same.

The combined bamboo area of the Hlaing Yoma and Okkan Reserves is 108,364 acres. Portions of these areas contain no bamboos, such as Taungya areas, roads, river beds, and scarps, while areas also exist from which the extraction of bamboos would be too difficult and costly, so that, for safety's sake, we may reduce it by 20 per cent. leaving 86,700 acres of productive bamboo forest to be dealt with. From Appendix I it will be seen that the forest can yield 8,254 lbs. of dry internodes of *Cephalostachyum pergracile* (Tinwa) and 9,255 lbs. of dry internodes of *Bambusa polymorpha* (Kyathaung) per acre, or a total of 17,509 lbs. or 7·81 tons per acre. Thus the gross yield of pulpable material works out at 676,527 tons or, working on a 5-year rotation, the sustained yield of dry internodes comes to 135,305 tons per annum.

(7) *Lines of export.*

In forming an estimate of the cost of extraction and the methods by which the bamboos could be exploited, the proposed factory site is taken to be on the Okkan river, somewhere near to the point where that river cuts the railway. (See red circle on map.) However, were the factory to be erected near Insein on the Hlaing, otherwise known as the Myitmaka river, the extra expense incurred in floating the bamboos another 30 miles or so down from the Okkan railway bridge would be relatively small.

The Okkan river, with its tributaries, of which the more important are the Yindaik, Kangya, Chaungyaung and Mingaung, completely taps the Okkan Reserve, while the main stream passes the proposed factory site at Okkan village. It is not a large river, being about 50 yards broad where it comes out of the reserved forest, and its bed is sandy, with few boulders to impede floating. It is the main stream by which bamboo rafts are brought down to the railway from the Okkan forests. These rafts, of which several were being taken down when the river was inspected, are constructed in the upper reaches of the river and floated down any time from the middle of June to the middle of January. In the smaller tributaries floating is not possible after October. After the bamboos have been dragged to the main or by-streams, a distance of one mile or less, they can be floated directly from the forest to the factory, the distance from the centre of the Reserve to that place being about 18 miles.

The work of extracting bamboos from the Hlaing Yoma Reserve is of a somewhat different nature. From Compartments 9 and 13 to 25 the bamboos can be dragged and carted to Thanachaung Railway Station (see map), an average distance of 8 miles, and from there they can be railed to the factory near Okkan station, a distance of about 15 miles, while Compartments 26 to 28 and 29 to 30 can be worked out by dragging for a mile or so and carting 7 miles to Palôn station, whence they can be taken by rail some 10 miles to the factory. The lines of export are therefore very suitable for the extraction of bamboos, for when the supply of raw material from the Okkan Reserve is no longer available, owing to insufficient water in the river for floating operations, *i.e.*, during six months in the year, it will be possible, owing to the fair weather roads being open to cart traffic during the dry season, to exploit bamboos from the Hlaing Yoma Reserve, thus ensuring a continuous supply of raw material throughout the year.

(8) *Cost of cutting and extraction.*

The cost of cutting 100 *Cephalostachyum pergracile* (Tinwa) bamboos, dragging them to a by-stream and floating them to the edge of the reserved forest, for instance to the village of Shawbon, comes to Rs. 2, and for *Bambusa polymorpha* (Kyathaung) Rs. 3 per 100. The cost of making them up into rafts and taking them down to the factory site will come to Re. 1 per 100, or a total cost of Rs. 3 per 100 for Tinwa and Rs. 4 per 100 for Kyathaung. The royalty on bamboos is annas 5 per 100, while Tinwa bamboos, 20 feet long, sell at present in the Okkan market for Rs. 4 to Rs. 6 per 100 and Kyathaung, Rs. 5 to Rs. 7 per 100, according to quality.

For the Hlaing Yoma Reserve the estimates are as follows: Cost of cutting and dragging to a cart-road, Rs. 2 per 100 for Tinwa and Rs.3 per 100 for Kyathaung. Carting costs 3 annas per mile, and the average distance of the forest from the Railway is 8 miles, or Re. 1-8 per cart. A cart can take 100 Tinwa or 33 Kyathaung, so that the total cost of landing Tinwa on the station works out to Rs. 3-8 and for Kyathaung Rs. 7-8, per 100. To these estimates must be added the cost of loading and railing the stuff some 15 miles to Okkan, say Rs. 2 per 100, which raises the total cost to Rs. 5-8 and Rs. 9-8 per 100, respectively.

(9) *Cost of landing dry internodes per ton at the factory site.*

The weight of dry internodes yielded by one average Tinwa bamboo is 7·6 lbs. and that by a Kyathaung 15·4 lbs. (see Appendix I), therefore it takes about 295 Tinwa or 145 Kyathaung to yield a ton of dry internodes. The cost of landing the bamboos from the Okkan Reserve at the proposed factory site is Rs. 3 and Rs. 4 per 100 respectively, so that the cost of landing dry internodes of Tinwa at the mill works out to Rs. 8-13-7 per ton and of Kyathaung at Rs. 5-12-9 per ton.

The cost of landing bamboos from the Hlaing Yoma Reserve is Rs. 3-8-0 and Rs. 7-8-0 per 100 respectively, so that the cost of landing dry internodes of Tinwa at the mill works out to Rs. 10-5-3 per ton and of Kyathaung at Rs. 10-14-0 per ton. Were the site of the mill fixed at Insein, 8 annas would have to be added to the cost per ton. In the event of the nodes being utilised, the average cost of Tinwa and Kyathaung together works out to Rs. 10 per ton in round figures, and this is the figure taken by Raitt for his estimates.

(10) *Labour.*

Local labour cannot be relied upon at all To begin with it is scarce and only obtainable in limited quantities after the rice crop has been reaped. A Burma cooly can earn 9 annas to Re. 1 per day according to the nature of the work on which he is employed. Cooly labour from India is obtainable at Rs. 12-0-0 per month, and is extensively employed and with advantage by the Forest Department for work such as clearing fire-lines. It will certainly be necessary to import coolies from India, for Burman labour cannot be relied upon in sufficient quantities to run a large pulp-mill.

Carts are procurable in small numbers only, so that here again importation will be necessary. It is not generally possible to hire elephants, and if it were contemplated to use them for dragging purposes they would have to be purchased.

(11) *Firewood.*

Firewood cannot be obtained easily, for though large quantities are forthcoming from the forests, the difficulty in exploiting it would be considerable. Were it to be floated down the streams, it would probably interfere either with the floating of the teak or with the bamboos, while carting would be too expensive. Coal will, therefore, be necessary, and its price would be but little higher than in Rangoon, especially were the site of the factory to be fixed not far up the river from Rangoon and at a place in direct connection with that port.

(12) *Chemicals.*

No lime is available in the vicinity of the Okkan Reserve, so that it will have to be procured from Rangoon, where the price is 5 annas per cubic foot. Excellent lime is procurable in large quantities from Moulmein. All other necessary chemicals will have to be imported to Rangoon by sea, and taken up the Rangoon river to the factory.

(13) *Miscellaneous facts.*

The proposed site for a mill at Okkan is surrounded on every side by open country, generally under rice cultivation. It is a fairly

healthy locality throughout the year and is well suited to Europeans. It has the advantage of being on a good floating stream and also on the railway, some 50 miles from Rangoon. It is possible that, were a mill to be erected on a large scale, a better site would be further down the river, a few miles above Insein and near Rangoon, but such a point can only be settled by the firm or company intending to start the business.

BURMA BAMBOO AREA NO. III. (*See portion marked* **C** *on map.*)

Pyinmana Division.

(1) *Name and Situation.*

The area from which bamboos can be extracted from the Pyinmana Division is a block of forests at the foot of, and on the eastern slopes of the Pegu Yomas, commencing some 10 to 15 miles east of the Rangoon-Mandalay Railway. The forests are of two types, the northern portion being in the dry zone and consisting of a poor quality Cutch forest, the central and southern portions being in the wet zone, and containing teak, pyinkado, and bamboos. It is with the latter type of forest that we are concerned. For the purpose of working out the timber from this area, it has been divided into nine blocks, of which four are drained by the Ngalaik and five by the Yonbin, both of these rivers finding their way into the Sittang, to the east and south-east of the town of Pyinmana.

(2) *Description of the forest.*

(*1*) *The Ngalaik drainage.*—The following blocks make up the catchment area of the Ngalaik:—

(*i*) The Taungyé Reserve is the most northern block, and is drained by a tributary of the Ngalaik, which bears the same name as that of the Reserve. The river in its upper reaches is a poor floating stream, so that the upper portions of the forest are excluded from this scheme, though bamboos cover nearly the whole area.

(*ii*) The Ngalaik Reserve lies inside the Taungnyé, with its north-west limits covering the crest of the Yomas, in which locality bamboos occur, but would be difficult to exploit.

(*iii*) The Kaing Reserve is a small area of forest, to the south-east of the Ngalaik Reserve and is drained by the Ngalaik itself.

(*iv*) The Pozaungdaung Reserve lies close to the Railway on hilly ground, but not on the main ridge of the Yomas; it is well stocked with bamboos, of which a certain number are extracted annually from its eastern edge by small contractors. The tributary of the Ngalaik, known as the Chaungmagyé, drains this area.

(2) *The Yonbin drainage.*

(*v*) The Yanaungmyin Reserve is a comparatively small area lying on undulating ground on the outside edge of the Yoma blocks, and is drained by a small river called the Thebyu, a tributary of the Yonbin.

(*vi*) The Plawé Reserve is the most northern block drained by the Yonbin. It lies up against the main ridge of the Yomas, consequently it is difficult to extract bamboos from its upper reaches. It is drained by the Palwé Chaung, a tributary of the Yonbin, and a good floating stream.

(*vii*) The Yonbin Reserve in the west lies on the main ridge of the Yomas, and is drained by the Chaungmangyi tributary, also a good floating stream.

(*viii*) The Mynbyin Reserve lies to the south of the Yonbin forests, and is tapped by the Yonbin Chaung, a good floating stream.

(*ix*) The last reserve is the Yeni, which contains fine pyinkado forests. It has been decided to omit this area from the scheme as the river by which it is drained is a poor floating stream.

(3) *Area.*

In calculating the area of forests of the various reserves over which bamboos occur, those lying along the main ridge of the Yomas have been excluded, as the difficulty in exploiting the bamboos from that locality would probably render the cost excessive.

Besides the above localities, certain of the areas contain a type of forest known as "Indaing" in which bamboos are non-existent, while others are covered with bamboos unsuitable for pulping. To arrive at the areas, over which *Bambusa polymorpha* (Kyathaung) and *Cephalostachyum pergracile* (Tinwa) occur, Mr. Leete, the Divisional Forest Officer, was consulted and also his Assistants, many of whom have many years' experience of these forests.

In this way the following figures have been arrived at :—

Name of Reserve.	Actual area of Reserved Forests, in acres.	Area covered by exploitable Kyathaung and Tinwa bamboos, in acres.
(*i*) Toungnyé Reserve	69,546	34,773
(*ii*) Ngalaik ,, ...	80,013	60,009
(*iii*) Kaing ,, ...	13,341	10,005
(*iv*) Pozaungdaung ,, . . .	51,557	12,889
(*v*) Yanaungmyin ,, ...	13,078	6,539
(*vi*) Palwe ,, ...	89,222	44,611
(*vii*) Yonbin ,, ...	78,034	39,017
(*viii*) Mynbyin	127,059	63,529
	521,850	271,372 acres or 424 sq. miles

(4) *Species of bamboos and mode of growth.*

The species of bamboos which predominate in these forests are *Bambusa polymorpha* (Kyathaung) and *Cephalostachyum pergracile* (Tinwa). Other species occur such as *Oxytenanthera albociliata* (Wanwé), *Dendrocalamus strictus* (Myin) on the drier ridges, and others, but only Kyathaung and Tinwa are taken into consideration for the purposes of this scheme.

The *Bambusa polymorpha* (Kyathaung) and *Cephalostachyum pergracile* (Tinwa) grow to a large size in these forests, especially the former. In order to ascertain the girth, length and weight of culms of these

species (see Appendix II), 200 Kyathaung and the same number of Tinwa were cut and measured. The former gave average measurements of 10·1″ mid-girth and 49 feet in length, the thin tops being cut off. In the same way 200 Tinwa were cut, giving an average mid-girth of 6·3″ and a length of 38 feet. The weight of these bamboos green and of the dry internodes is dealt with under the heading (6) Outturn.

(5) *Factory site.*

The obvious site for a factory is somewhere on the Sittang river, but no suitable place exists over its course through the Pyinmana Division as the Railway runs at some distance from the river. It will, therefore, be necessary to fix a site lower down in the Toungoo Division, and the place suggested by Sindall in his report on the possibility of pulp manufacture in Burma (1906) is at the village of Kywebwé, which lies on Railway some 18 miles below Toungoo (see map). On visiting this place it was found that the river was two miles distant from Kywebwé and that it would be better to place the mill at Myozo, on the Sittang, which here runs between high banks (see map). A road, which was at the time of inspection in very bad order, joined the river with the rail. To exploit bamboos from the Pyinmana forests would necessitate floating an average distance of 40 miles down the Ngalaik and its tributaries and 120 miles from the junction of the Ngalaik and Sittang to the mill at Myozo.

All chemicals, except possibly lime, would either have to be railed up from Rangoon, a distance of 186 miles, or brought up the Sittang in boats, as the river is sufficiently deep to allow boats of 25 tons burden to ply up to Myozo.

(6) *Outturn.*

A certain number of bamboos are exploited annually from the Pyinmana forests by purchasers and right-holders; in 1909-10 the number taken out by the former was 72,700 and by the latter the number is estimated at 300,000. Compared with many other divisions in Burma this is a very small number.

The possible outturn of Kyathaung and Tinwa bamboos is based on the enumerations made in the Pyinmana and Toungoo Divisions and on weighings taken of a large number of cut stems. It has been thought advisable to take the average of the countings in both Divisions, as the

forests in both localities are very similar, being situated on the eastern slopes of the Pegu Yomas.

From Appendix II it will be seen that the average yield of dry internodes of both Kyathaung and Tinwa is 39,047 lbs. or 17·6 tons per acre. The area of forests covered by these bamboos is 271,372 acres, giving a gross yield of 9,596,262,284 lbs. or 4,775,147 tons of dry internodes. Estimating that the forests can be cut over once in five years, the possible sustained yield of dry internodes works out at 955,029 tons per annum.

(7) *Lines of export.*

The bamboos will have to be dragged from two to three miles to the nearest floating stream, and thence floated down the Ngalaik and Yonbin Chaungs to the Sittang river. Floating is only possible in the rains, and even then only in times of flood. This would seem to rule out these forests as a suitable locality whence the raw material could be exploited; on the other hand, very large quantities of teak are floated down annually by these streams, and there appears to be no reason why bamboos should not also be extracted in the same way. Mr. Leete, the Divisional Forest Officer, expressed it as his opinion that the work could be carried out without difficulty. On the Sittang floating is possible throughout the year.

The only forest in which it is possible to exploit bamboos by carts is the Yanaungmyin Reserve, and this could only be done in the open season.

The various distances over which it will be necessary to float bamboos the forest to the Sittang are as follows, the distance from the junction of the Sittang and Ngalaik to the mill being 120 miles :—

(*i*) The Taungnyé Reserve, from 20 to 40 miles.
(*ii*) The Ngalaik Reserve, from 45 to 60 miles.
(*iii*) The Kaing Reserve, from 30 to 40 miles.
(*iv*) The Pozaungdaung Reserve, from 20 to 40 miles.
(*v*) The Yanaungmyin Reserve, 20 miles.
(*vi*) The Palwé Reserve, from 35 to 60 miles.
(*vii*) The Yonbin Reserve, from 25 to 50 miles.
(*viii*) The Minbyin Reserve, from 29 to 50 miles.

At present the rafting work on the Ngalaik and Yonbin is done by local men, two men bringing down a raft of 150 Kyathaung, or of 200

Tinwa. On reaching the Sittang the rafts are enlarged and contain 1,000 stems or over.

(8) *Cost of cutting and extraction.*

The price of bamboos in Pyinmana is Rs. 5 to Rs. 6 per 100 for Kyathaung in the rains and Rs. 8 per 100 in the open season. Tinwa are generally sold at a little over half that rate.

The cost of cutting and dragging to the river, an average distance of 1½ miles, comes to Re. 1-8 per 100 for Kyathaung. The cost of floating, from the centre of the forest to the Sittang, costs Rs. 3-8 and the cost of floating in large rafts to the mill at Myozo is estimated to cost Rs. 2-8. The total cost of landing Kyathaung at the mill, therefore, works out to Rs. 7-8 per 100. Tinwa being much smaller and more easy to handle, the total cost is put at Rs. 6 per 100.

(9) *Cost of landing dry internodes per ton at the mill.*

From Appendix II, it will be seen that a Kyathaung bamboo yields 25·6 lbs. and a Tinwa yields 12·05 lbs. of dry internodes. Therefore, it takes 87 Kyathaung and 186 Tinwa to make up a ton of dry internodes. The cost of exploiting 100 Kyathaung to the mill costs Rs. 7-8 and of 100 Tinwa Rs. 6, so that the cost of landing one ton of dry internodes of Kyathaung at the mill works out to Rs. 6-8-5 and of Tinwa to Rs. 11-2-6.

(10) *Labour.*

The general opinion of the local officers is that sufficient labour will be forthcoming in the rains to exploit one and a half million bamboos and that petty contractors will be found to do the work. If more labour is necessary it will have to be imported. The price of labour is 8 annas per man, but in the harvest season it is generally higher. Burman carpenters and masons are procurable at Re. 1 per day, while Chinese carpenters can earn as much as Rs. 2 per day.

(11) *Chemicals.*

The cost of lime is 8 annas per 100 lbs. in Pyinmana. It is procured from a village called Chaungza, in the Paunglaung Range, about 6 miles east of the railway. The lime-stone is obtained from surface workings,

20 to 25 kilns being worked by the local population. The strata are said to be fairly extensive, and the lime is of excellent quality, though the former statement requires verification.

(12) *Fuel.*

As the proposed factory site is in the Toungoo Division the question of the supply of fuel must be considered for that locality. It is plentiful and can be brought down by boat to the mill door at a cost of Rs. 8 to Rs. 10 per ton.

(13) *Miscellaneous.*

The Pyinmana forests contain large quantities of pyinkado, a timber that does not float, and it has been suggested that, if this were sold, the bamboos required to float it out might afterwards be used as raw material for the manufacture of paper-pulp. The mill site suggested at Myozo lies in the wet zone but is, generally speaking, not unhealthy, and is a quiet and suitable place for Europeans to live in, provided proper accommodation is available. The Pyinmana forests are not healthy in the rains, especially during November, though the large firms working out the timber in these forests employ European supervision throughout the wet season.

BURMA BAMBOO AREA NO. IV. (*See portion marked* ***D*** *on map*).

Toungoo Division.

(1) *Name and Situation.*

(*i*) *Areas to the west of the Sittang river.*

The main ridge of the Pegu Yomas runs parallel to the Sittang and the railway at a distance of 50 miles. Between the hills and the river occur 14 Forest Reserves, the main block lying up against the hill range, while outlying blocks occur nearer, though never touching the Sittang river. The whole of these forests are drained by feeders of the Sittang, of

which the Kabaung and the Swa are the most important for floating purposes (see map). Of the 14 reserves, only four are suitable for the extraction of bamboos, namely, the Bondaung and Kabaung in the south drained by the Kabaung tributary and the East Swa and Saing Yané Reserves drained by the Swa. The other reserves are either too distant or are drained by rivers in which floating is difficult.

(ii) Areas to the east of the Sittang river.

To the east of the main stream are found four reserves of small size; moreover, there are extensive areas of unclassed forest containing many bamboos. The most important tributary on this side of the river is the Thaukyegat, which joins the Sittang near Toungoo. This river drains extensive Unreserved Forests. To the north of this river, there are six small tributaries in the Toungoo Division, all of which pass through Unreserved Forests containing bamboos.

(2) *Description of the forests.*

The four blocks to the west of the river, with which this scheme deals, are situated on hilly ground, rising in places to over 1,000 feet. The northern portion of the Bondoung Reserve is drained by the Kabaung, while the southern portion is drained by a small tributary down which it would be difficult to float bamboos and so it has been excluded from the bamboo-yielding area.

The Kabaung reserve, which lies to the west of the above reserve, is drained down the centre by the river of the same name. It is not possible to extract bamboos from the whole reserve, as the Kabaung is a rocky stream above its junction with the Kyetsha Chaung.

Both blocks contain dry to moist deciduous teak, pyinkado and bamboo forest, the chief species of bamboo being *Bambusa polymorpha* (Kyathaung), while *Cephalostachyum pergracile* (Tinwa) also occurs in fair quantities, but is still immature having flowered in recent years. The type of forest in the two northern blocks, on the Swa River, resembles that in the Kabaung Reserve, but is somewhat drier, the East Swa Reserve being drained by the main stream and its tributary the Lonyan Chaung, while the Saing Yané Reserve is drained by a tributary known as the Saing Chaung, which in its upper reaches is not a good floating stream.

To the east of the Sittang, the Thaukyegat Chaung is the most important tributary and drains extensive areas of Unreserved Forests, containing much pyinkado and bamboos, as also in places "Indaing" (*Dipterocarpus tuberculatus*) in which the bamboo is scarce or entirely absent. To the north of this river occur smaller forests from which a certain number of bamboos could also be exploited.

(3) *Area.*

The reserved forests of this Division are very extensive and contain masses of bamboos. As was mentioned before, many of these forests are remote from good floating streams or floating is not practicable along some of the larger rivers, such as the Pyu and Kun, owing to the presence of rocky gorges where they enter the plains. For this reason, the areas from which bamboos can be exploited are relatively small as compared with the total areas under forest.

The forests from which bamboos can be extracted are as follows:—

Name of Reserve.		Actual area of Reserved Forests, in acres.	Forests from which bamboos can be exploited, in acres.
Kabaung drainage	Bondaung Reserve . .	23,757	10,330
	Kabaung Reserve . .	188,934	17,240
	Unreserved Forest . .	Not known.	10,000
Swa drainage	East Swa Reserve . .	13,555	....
	Lower Saing Yané Reserve	70,176	15,000
Thaukyegat drainage.	Unreserved Forest, east of the Sittang.	Not known but very large.	10,000
Drainage of six small feeders of the Sittang.	Unreserved Forest on east bank of the Sittang and north of Toungoo.	Ditto .	12,000
		..	74,570

Both Mr. Rorie, the Divisional Forest Officer, and the writer of this report consider the estimate of 74,570 acres to be a low one, and well on the safe side.

(4) *Species of bamboos and mode of growth.*

By far the most abundant species of bamboo found in the Toungoo forests is *Bambusa polymorpha* (Kyathaung). It grows here to a large size, averaging 49 feet long when cut off at 2″ girth at the thin end and with a mid-girth of 10·1″: *Cephalostachyum pergracile* (Tinwa) comes next in importance after Kyathaung. This species flowered about 1905, the old clumps after producing seed died down and at present the ground is covered with seedlings which in a few years will produce large quantities of bamboos.

Bambusa Tulda (Thaikwa) and *Dendrocalamus strictus* (Myinwa) occur locally in fair quantities but are not nearly so abundant as the first two species mentioned.

(5) *Factory site.*

The factory site is the same as that proposed for the Pyinmana scheme, namely Myozo, some 18 miles down the Sittang from Toungoo. (See map.)

(6) *Outturn.*

The number of bamboos exploited in 1909-10 from the Reserved and Unreserved Forests of the Toungoo Division was as follows :—

From Unreserved Forests.

Range.	Locality.	Number.	Rate.	Amount.
			Rs. a. p. per 100	*Rs. a. p.*
Pyunchaung . .	Unreserved . . .	200,200	0 5 0	625 10 0
Pyu . . .	Ditto . . .	258,700	0 5 0	808 7 0
Yedashé . . .	Ditto . . .	11,200	0 5 0	35 0 0
Thagaya . .	Ditto . . .	16,800	0 5 0	52 8 0
Gwethé . . .	Ditto . . .	149,500	0 5 0	467 3 0
Kabaung . .	Ditto . . .	192,700	0 5 0	602 3 0
	Total Unreserved Forests .	829,100		2,590 15 0

From Reserved Forests.

Range.	Locality.	Number.	Rate.	Amount.
			Rs. a. p. per 100	*Rs. a. p.*
Pyunchaung . .	Chaungmaugé Reserve .	300	0 5 0	0 15 0
,, . .	Mezindein Reserve .	12,000	0 5 0	37 8 0
Pyu . . .	Kauguthuri Fuel Reserve.	1,000	0 5 0	3 2 0
,, . . .	Myayabin Reserve .	2,100	0 5 0	6 9 0
Thagaya . .	Myohlabes ,, . .	20,900	0 5 0	65 5 0
,, . . .	E. Swa ,, .	38,000	0 5 0	118 12 0
,, . . .	Saing ,, .	8,400	0 5 0	26 4 0
Yedashé . .	Lonyan ,, . .	1,500	0 5 0	4 11 0
,, . . .	W. Swa ,, .	12,700	0 5 0	39 11 0
Gwethé . .	Gwethé ,, .	5,600	0 5 0	17 8 0
,, . . .	Kanin ,, .	3,100	0 5 0	9 11 0
Kabaung . .	Kabaung ,, .	47,200	0 8 0	236 0 0
	Total Reserved Forest	152,800	..	566 0 0
	GRAND TOTAL .	981,900	..	3,156 15 0

The possible outturn of Kyathaung and Tinwa bamboos is based on the enumerations made in the Pyinmana and Toungoo Divisions, the latter countings having been made by Mr. Rorie, the Divisional Forest Officer. The calculations of the weight of the green bamboos and dry internodes is based on weighments made of 200 average Kyathaung and 200 Tinwa bamboos, cut in the forests in which the enumeration plots were taken. From Appendix II it will be seen that the average yield of dry internodes of both Kyathaung and Tinwa is 39,047 lbs. or 17·6 tons per acre. The area of the forest, from which it is possible to exploit these bamboos, is 74,370 acres, giving a gross yield of 2,903,925,390 lbs. or

1,309,212 tons of dry internodes. Estimating that the forests can be cut over once in five years, the possible sustained yield of dry internodes works out at 261,842 tons per annum.

(7) *Lines of export.*

The bamboos will have to be dragged a maximum distance of two miles to the rivers after being cut, and floated down to the Sittang and again some 20 miles down that river to Myōzo, the proposed factory site. The chief floating streams are as follows :—

(*i*) The Kabaung, a large stream down which bamboos can be floated up to the end of February. This river taps the Bondaung and Kabaung Reserves. Above the point where its tributary the Kyetsha Chaung comes into the main stream, the bed is rocky, so that the area above this point has been excluded from this scheme. To overcome this difficulty of floating in streams with rocky beds, Mr. Walker, Burma Forest Officer, has suggested cutting up the bamboos into sections, each section to contain at least 2 internodes, so that an air-tight chamber occurs in each piece and then to float them down separately. This has never been done but would seem to be a by-no-means impossible way of getting over the difficulty.

(*ii*) The Swa river, which taps the East Swa Reserve, enters the Sittang some 40 miles above the proposed mill site at Myozo. Its tributary the Saing Chaung, which is also a large stream, taps the Saing Yané Reserve. It is a good floating stream down which bamboos can be brought from the village of Lonyānbauk up to the end of February.

(*iii*) The Thaukyegat is a large perennial stream on the east bank of the Sittang, and joins that river just below Toungoo. It possesses the great advantage in that bamboos can be floated down its channel throughout the year.

(*iv*) Bamboos can also be obtained by floating them down the other small streams which occur on the east bank of the Sittang, to the north of Toungoo.

(*v*) Small quantities of a few hundred tons can also be extracted by carts from the hill forests directly west of Myozo, the lead by road being not more than seven miles.

(8) *Cost of cutting and extraction.*

The present price of Kyathaung in Toungoo is Rs. 6 per 100 and Rs. 6 to Rs. 7 per 100 for Tinwa.

The cost of cutting and dragging Kyathaung to the floating streams is put at Re. 1-8 per 100; the cost of floating to the Sittang, from the centre of the Kabaung or East Swa Reserves, is estimated to cost Rs. 3-8 per 100; and the cost of preparing large rafts and floating them down the Sittang, an average distance of 30 miles, is put at Re. 1-8, giving a total of Rs. 6-8 per 100 landed at the mill. Tinwa, being smaller and easier to handle, can be brought out for Rs. 5 per 100.

(9) *Cost of landing dry internodes per ton at the mill.*

From Appendix II it will be seen that a Kyathaung bamboo yields 25·6 lbs. and a Tinwa yields 12·05 lbs. of dry internodes. Therefore it takes 87 Kyathaung and 186 Tinwa to make up a ton of dry internodes. The cost of exploiting 100 Kyathaung to the mill costs Rs. 6-8 and 100 Tinwa Rs. 5, so that the cost of one ton dry Kyathaung internodes at the mill works out to Rs. 5-10-6 and of Tinwa to Rs. 9-4-9.

(10) *Labour.*

Mr. Rorie, the Divisional Forest Officer, Toungoo, anticipates difficulty in procuring an adequate supply of labour, and it is fairly certain that it will be necessary to import coolies from outside the district. In order to indicate the wages now being paid at Myozo, the proposed mill site, it may be stated that a cooly earns Rs. 13 to Rs. 15 per month working at the Myozo Saw-mill, and that the Engineer-in-charge is paid Rs. 110 per mensem.

(11) *Chemicals.*

The cost of lime at Toungoo is 8 annas per 100 lbs. and this must be either procured from the Pyinmana Division (see page 58) or from Rangoon or Moulmein. It is just possible that the other necessary chemicals could be run up the Sittang in boats, but on this point it is difficult to make any statement with certainty. Otherwise they would have to be railed up from Rangoon to Kywebwé and carted two miles to Myozo.

(12) *Fuel.*

Fuel is plentiful in this Division, and a certain amount could always be procured from the many saw-mills along the Sittang. It can also be obtained by floating it down the river from the Unreserved Forests. It would probably cost from Rs. 8 to Rs. 10 per ton landed at the mill.

(13) *Miscellaneous.*

The remarks made on page 59 regarding the possibility of floating out bamboos in conjunction with pyinkado apply with equal force to this Division. The great advantage of utilizing these forests for the supply of raw materials lies in the fact that floating can be carried out throughout the year down the Thankyegat Chaung.

Myozo is a healthy place, though the forests during November and December are by no means healthy. The most difficult point to be settled is the labour question, about which it is difficult to obtain reliable information.

Burma Area No. V.

Arakan Division.

(1) *Name and Situation.*

The conditions which indicate the feasibility of extracting bamboo for paper-pulp in other districts of Burma, which have been described above, differ *in toto* in Arakan. The species of bamboo is different to that found in Burma proper, while the local conditions are peculiar to Arakan, and will therefore require to be described in detail.

The forests from which bamboos can be extracted cover the various catchment areas, the drainage of which finds an outlet at or near the seaport of Akyab (see map). This part of the district lies north and north-east of Akyab and is drained by three large rivers, namely the Mayu to the west, the Kaladan in the centre and the Lemru to the east. The Arakan coast-line here runs more or less north-west and south-east, while the three above-mentioned rivers run from north to south converging on Akyab, and are separated by parallel lines of hills rising to about

300 feet. Owing to the existence of a waterfall on the Seik Chaung, a tributary of the Mayu, which occurs about 60 miles from the sea and which it is thought, might possibly be utilized to generate power for a mill, this scheme has been divided into two parts. The first dealing with the forests lying above this waterfall, the raw produce from which could be worked out to a mill just below the falls, and the other dealing with the forests on each side of the Kaladan and Lemru, the bamboos from which could be exploited to Akyab.

A.—FORESTS OF THE SEIK CATCHMENT AREA.

(See small portion marked E on map.)

(2) *Description of the forests.*

The catchment area, in which these forests occur, is, generally speaking, narrow and long, the main stream having few feeders of importance throughout the area, except one on the east bank, called the Rhee Chaung, which is nearly as large as the main stream and joins it just above the waterfall. The forests were originally of an evergreen type but this class of forest has gradually disappeared and is now found only along the banks of the rivers and on the steeper slopes. The rest of the area is now covered with a dense crop of bamboos, known locally by the name of Kayin (*Melocanna bambusoides*), in which practically not a single tree is to be seen. This peculiar type of bamboo growth has been brought into existence by a method of shifting cultivation known as "Taungya." It is carried out by the hillmen and consists in cutting down the original forests, burning the timber and brushwood when dry and sowing rice and cotton seed in the ashes; they then desert the place, after reaping the crop, and go on to another area. As this system of cultivation has been going on for many generations, the original forests have practically disappeared, leaving these hill tracts covered with masses of bamboos of varying ages.

Each household cuts about three acres a year, and now that the people have cleared out the virgin forests, they go back every six or seven years to their original area and instead of cutting and burning tree growth, which has, as a matter of course, disappeared, they clear out the six to seven-year old bamboos, and burn them in order to obtain the ash in which to sow the seed.

(3) *The area of forests covered by bamboos.*

The areas dealt with are not organised ; in other words, no Working-Plans have been prepared, so that the exact size of the catchment area of this river is not known. From the available maps it would appear to be about 150 square miles, of which 90 square miles may be taken into account, from which it is possible to exploit bamboos, namely, one mile on each side of the river, from a point above the waterfall and similarly one mile up each side of its tributary, the Rhee Chaung. This figure has been arrived at after inspecting the greater portion of the whole area.

(4) *Species of bamboo and mode of growth.*

The species found in these forests is *Melocanna bambusoides*, with a comparatively small thin-walled stem, which does not grow in clumps, like most other bamboos, but sends out shoots from a ramification of rhizomes in the same way as suckers are put out by tree roots. The result of this mode of growth is that the ground is covered with stems standing at more or less equal distances, one from another, and not in clumps, as is generally the case with such species as *Cephalostachyum pergracile* or *Bambusa polymorpha*. A number of stems were measured on a recently cut " taungya " area, which was covered with seven-year-old growth, and were found to average 20·1* feet in length and 3·0″ mid-girth. Another lot numbering 10,575 was cut by Mr. Walker, Divisional Forest Officer, Arakan, and gave an average of 22 feet in length and 3·8″ mid-girth (see Appendix III).

As has been mentioned above, the bamboo forests contain blanks under cultivation, and elsewhere growth of one, two, three, and up to seven-year-old bamboos, each age-class being separate. The one-year-old growth is about 12 feet high, the second about 15 feet, until at seven years of age it is from 30 to 35 feet high.

(5) *Possible factory site.*

The reason for dividing this scheme into two parts is that there occurs a fine waterfall on the Seik Chaung, above the village of Ponnyaleik, the fall being some 60 miles up the river from Akyab, while the other two catchment areas in this part of the country drain down direct to that town and could therefore not be conveniently worked out to a mill

*NOTE.—The thin end having been cut off before the culms were measured.

situated just below the falls. In the event of the falls being utilized for the purpose of working a pulp-mill, the site could be chosen below the falls and the area above utilized for the extraction of the bamboos.

The falls are situated on the Seik Chaung, shown on the map south of the smaller portion marked E, and just outside the bamboo area. The Seik Chaung is a large tributary of the Mayu river, and at the place, where they meet, the river is about 200 yards broad. The falls themselves consist of three steps, the upper one having a drop of 16 feet and separated from the second by a sloping ledge 300 yards long, falling some 14 feet over its length. The middle falls are 30 feet high and are divided from the third or lower fall by a stream 100 yards in length, which drops 20 feet, the lower cascade being about 10 feet in height. The total fall of the river over a distance of 400 yards, is therefore about 90 feet.

The cause of these falls is due to a peculiar formation of rock running at right angles across the river like a wall, a feature which is especially marked on the upper falls, so that there would be little difficulty in training the stream in order to concentrate the flow of water into one channel. On either side of the falls, the banks of the stream are precipitous, especially on the west side; on the east bank, there occurs a ledge or spur along which the water could be taken, were the stream to be tapped at the upper falls. This ledge runs down the east bank for about half a mile and emerges on to a fairly level stretch of open ground, on which a mill could be erected.

During the monsoon months a great volume of water passes over these falls but diminishes as the dry season advances. At the time when these falls were inspected, at the beginning of February, the stream flowing over the central falls was about 40 feet broad with a very fair volume of water coming over. In the event of these falls being taken into consideration as a possible power station for a pulp-mill, it would be necessary for the interested parties to send an engineer to inspect them during April, so as to ascertain the power available during the dry months.

The proposed site below the falls has also the great advantage that large lighters and small steamers can come up to this point throughout the year at high tide, and thus connect up the place directly with the seaport of Akyab.

Lastly, fresh water is obtainable at this place in large quantities which is a distinct advantage, especially in a locality where most of the streams are tidal for long distances up from the sea.

(6) *Outturn.*

A sample plot was taken by Mr. Walker, Divisional Forest Officer, Arakan, in which he clear cut exactly one acre of bamboo growth, and counted and weighed all the stems. The results of this operation are given in Appendix III. As the nodes in this species of bamboo are very small, they have not been taken into account as both internode and node can be pulped together. The yield, per acre, of dry stems is 16,576 lbs, the area from which bamboos can be extracted is estimated to be 57,600 acres, so that the gross yield works out to 426,240 tons. Working on a seven-year-rotation we get an annual sustained yield of 60,891* tons.

Though the quantity of bamboos stated above could be exploited annually, at present the whole of the bamboo forests are worked over by the Taungya cutters who monopolise the whole areas, so that, unless these cutters were largely restricted or entirely turned out, there would be no place for a mill. The Taungya cultivators leave a surplus which would be available for the mill but it would not in any way be sufficient to keep it running throughout the year. It would, therefore, be imperative for the interested parties to approach the Burma Government before prosecuting further enquiries in this locality.

A possible solution to the difficulty would be to employ the Quamis who cultivate this area, in cutting and extracting the bamboos, though it would have to be borne in mind that they are a hill tribe knowing little about contract obligations and therefore could not be relied upon, until they had been taught to work more methodically than at present.

(7) *Lines of export.*

The Seik Chaung, down which the bamboos can be floated to the falls, is 50 yards wide, 30 miles above the proposed mill site, increasing to 200 yards at the falls. Over the upper 25 miles of its course it is a deep channel flowing slowly between steep banks, covered with dense evergreen forest. These forests are, however, only a fringe along its banks, while the hills above are covered from end to end by a dense pure crop of bamboos.

*NOTE.—This is thought to be an extremely conservative figure.

The last five miles to the falls are a series of cataracts divided by deep holes, the bad portions of the channel being more or less divided into three sections. At present, bamboos are floated down the entire length of the river, being dragged over the rocky portions, while, at the main falls, they are thrown down and collected into large rafts in the deep pools at the foot of the falls. Without doubt, the stretches, over which floating is at present difficult, could be greatly improved by clearing the main channel of boulders and rocks, and this at no great expense. The stream in February was found to be broad and the amount of water was quite sufficient for rafting purposes. Probably for two months of the hot weather, dragging would be necessary over short lengths of difficult channel within five miles of the main falls.

The stream below the falls is deep and broad so that a pulp- mill, situated on the east bank of the river, would be in direct communication by water with Akyab, a port that large steamers can enter throughout the year.

(8) *Cost of cutting and extraction.*

The Seik Chaung, above the falls, has a long narrow catchment area, so that, the distance, over which the bamboos will have to be dragged to the stream, will not exceed one mile. On the other hand, with the exception of the Rhee tributary, there are few by-streams down which floating is possible. The present cost of extracting bamboos to the falls is Re. 1 per 100; were work to be carried out on a large scale, under proper supervision, the cost could no doubt be reduced. The price of bamboos in Akyab is at present Rs. 2 per 100.

(9) *Cost of landing dry stems per ton at the factory site.*

The weight of 10,575 dry stems is 16,576 lbs. so that 100 stems weigh 155 lbs. The weight of the nodes, as before stated, need not in this case be taken into consideration. It therefore requires 1,452 bamboos to make one ton. The cost of landing 100 bamboos at the falls is Re. 1, so that the cost of one ton of bamboos at the proposed factory site, *i.e.*, just below the falls, comes to Rs. 14-8-1.

(10) *Labour.*

It is probable that, if Government decides to stop Taungya cutting in any given area, it will insist on a serious attempt being made to employ

the local cutters in felling and extracting the bamboos. In any case Chittagong coolies, who come over in great numbers during the harvest season, would be available. A labourer can earn 8 annas a day and during the rice harvest probably double that amount.

(11) *Firewood.*

Were the falls utilized for working a power station, a considerable reduction could be made in the amount of fuel required.

(12) *Chemicals.*

Good lime is available from Ramree Island, close to Kyaukpyu, a fair quantity of which is annually imported to Akyab, where it fetches Rs. 65 per 100 maunds (80 lbs. per maund). It is probably possible to obtain coral outside Akyab harbour, but this point requires verification. All other chemicals necessary will have to be imported by sea to Akyab port.

(13) *Miscellaneous.*

The whole scheme is based on the assumption that Taungya cutting will be restricted or stopped, otherwise all hope of success must fall to the ground. The area and local conditions appear to be admirably suited for the purpose of the pulp-mill, as dense forests of bamboos occur in this catchment area, the river is well suited to floating, especially if the channel just above the falls is improved, big boats can come right up to the proposed mill site from Akyab, the cost of extraction is not prohibitive, while the waterfall may quite possibly be found suitable for working a mill.

B.—FORESTS OF THE KALADAN AND LEMRU CATCHMENT AREAS.

(*See large portion marked E on map.*)

(1) *Description of the forests.*

The Kaladan and Lemru are two large streams, having their sources far up in the Arakan Hill Tracts, flowing southwards between parallel ranges of hills and both finding an outlet at the sea-port of Akyab. The

Kaladan is the larger of the two streams, with several large tributaries, the most important of which are the Yo and Pi Chaungs on its west bank, and the Mi Chaung on its east bank. It is navigable for large launches up to Paletwa, some 100 miles from its mouth.

The Lemru lies to the east of the Kaladan and is navigable up to a point about 60 miles from the sea. It has many large tributaries, the most important of which are Tagwé, Wat and Than Chaungs on its east bank and the Ru Chaung on the west bank. Both the Kaladan and Lemru pass through bamboo forest in the upper half of their courses, while their tributaries tap extensive bamboo areas in the by-valleys. The type of forest in these localities is the same as that described in Part A being, generally speaking, covered with bamboos resulting from "Taungya" cutting.

(2) *Area of forest covered with bamboos.*

The area of Protected Forest north of Akyab, as given in the Administration Reports, is 8,050 square miles. It is not possible to state, with accuracy, what portion of this is covered by bamboo growth, but from the general aspect of the country it is put at 3,000 square miles, which is probably a low estimate.

(3) *Species of bamboo and mode of growth.*

The species of bamboo, its mode of growth, and the system under which the forests are worked by Taungya cutters, are the same as described in Part A.

(4) *Possible factory site.*

In this case the proposed site is at Akyab, for the reason that both rivers find an outlet at this port, and that the bamboos from both areas can be brought down to this place without difficulty. The chief difficulty, which presents itself here, is the supply of fresh water, as the only source available is a tank which supplies the town. At present the quantity available is hardly sufficient for domestic purposes, and a scheme has been started to increase the supply, so that there will be about one million gallons in excess of what is necessary for the town of Akyab. This amount would not be sufficient for a pulp-mill, so that further storage tanks would have to be prepared. Otherwise Akyab presents many advantages, being a good port and geographically well situated.

(5) *Outturn.*

It is not possible to give any figures of outturn for these localities. The conditions described in Part A of this scheme apply to these forests, namely, that the bamboo growth is cut over by Taungya cutters every 6th or 7th year, and that the bamboo forests are monopolized by them for this purpose. On the other hand, as the area of forest is in this case very large, the surplus supply of bamboos, over and above that utilized by Taungya cutters, is considerable. As an instance in proof of the above statement, it may be pointed out that the amount taken out in 1908-09 to meet the local demand amounted to 779,900 stems from the Kaladan and 1,050,300 from the Lemru catchment areas.

To obtain a large supply of bamboos, it would be necessary to go far up into the hills, as the local supply, which is obtained from the balance left over by the Taungya cutters, comes from areas relatively close to Akyab.

Owing to want of time, it was only found possible to carefully inspect the Seik catchment area, so that in the event of any persons wishing to go further into the matter, a more detailed enquiry into the Kaladan and Lemru catchment areas would be necessary.

As stated above, it is not possible to give definite figures of outturn, as it is not known what amount will be available after the "Taungyas" have been cut each year and the local demands have been satisfied. It must, however, be considerable, and it is thought that a sufficient quantity will be available to run a large pulp-mill. Were the "Taungya" cuttings restricted or stopped, the supply would be enormous.

(6) *Lines of export.*

Floating is feasible throughout the year, even in the upper reaches of the Kaladan, the Lemru and their tributaries; in this connection no difficulties are anticipated.

(7) *Cost of cutting and extraction.*

The price of bamboos at Akyab is from Re. 1-12 to Rs. 2 pe 100. This includes cost of extraction, floating, profit to the contractor and 5 annas for royalty. Were bamboos to be exploited on a large scale, they could be landed at Akyab at Re. 1-8 per 100.

(8) *Cost of landing dry internodes per ton at the mill.*

From weighments of ten-year-old dry bamboos taken by Mr. Walker (see Appendix III) a dry bamboo was found to weigh 1·55 lbs., so that it requires 1,452 bamboos to make a ton. The price is Re. 1-8 per 100 at Akyab, so that the cost of one ton of raw material comes to Rs. 21-12.

(9) *Labour, firewood and chemicals.*

The notes made in Part A, under these headings apply with equal force to this portion of the Arakan scheme.

(10) *Miscellaneous.*

In this instance, the scheme is not so much based on the assumption that Taungya cutting will be stopped or restricted, as on the existence of a surplus quantity of bamboos being available after the Taungya cutters have been supplied with their requirements. Such a stand-point was impossible in the case of the Seik catchment basin, as the area there is comparatively small and the surplus small in proportion. In the Kaladan and Lemru catchments, the area covered with bamboo is very much greater, so that the available surplus must necessarily be far greater than is the case in the smaller area.

There appears to be only one drawback to Akyab as a possible factory site, and that is the question of fresh water. This might possibly be overcome by utilizing water from the tank supplying the town: the supply could be further helped out by preparing storage tanks, a quite feasible proposition when it is taken into consideration that the annual rainfall in this locality is over 200 inches.